Rickettsia

General Features

Rickettsia is a genus of nonmotile, Gram-negative, nonspore-forming, highly pleomorphic bacteria that may occur in the forms of cocci (0.1 μm in diameter), bacilli (1–4 μm long), or threads (up to about 10 μm long). The term "rickettsia" has nothing to do with rickets (which is a deficiency disease resulting from lack of vitamin D); the bacterial genus *Rickettsia* was named after Howard Taylor Ricketts, in honour of his pioneering work on tick-borne spotted fever.

The rickettsia are bacteria which are obligate intracellular parasites. They are considered a separate group of bacteria because they have the common feature of being spread by arthropod vectors (lice, fleas, mites and ticks). The cells are extremely small (0.25 u in diameter) rod-shaped, coccoid and often pleomorphic microorganisms which have typical bacterial cell walls, no flagella, are gram-negative and multiply via binary fission only inside host cells. They occur singly, in pairs, or in strands. Most species are found only in the cytoplasm of host cells, but those which cause spotted fevers multiply in nuclei as well as in cytoplasm. In the laboratory, they may be cultivated in living tissues such as embryonated chicken eggs or vertebrate cell cultures.

The family Rickettsiaceae is taxonomically divided into three genera:

1. *Rickettsia* (11 species)--obligate intracellular parasites which do not multiply within vacuoles and do not parasitize white blood cells.

2. *Ehrlichia* (2 species) - obligate intracellular parasites which do not multiply within vacuoles but do parasitize white blood cells.

3. *Coxiella* (1 species)--obligate intracellular parasite which grows preferentially in vacuoles of host cells.

4. *Baartonella* (3 species)--intracellular parasite which attacks the red blood cell.

Structure

The structure of the typical rickettsia is very similar to that of Gram-negative bacteria. The typical envelope consists of three major layers: an innermost cytoplasmic membrane, a thin electron dense rigid cell wall and an outer layer. The outer layer resembles typical membranes in its chemical composition and its trilaminar appearance. The cell wall is chemically similar to that of Gram-negative bacteria in that it contains diaminopimelic acid and lacks teichoic acid. Intracytoplasmic invaginations of the plasma membrane (mesosomes) and ribosomes are also seen. There are no discrete nuclear structures.

Metabolism

In dilute buffered salt solutions, isolated rickettsia are unstable, losing both metabolic activity and infectivity for animal cells. If, however, the medium is enriched with potassium, serum albumin and sucrose, the isolated organisms can survive for many hours. If ATP is added to the solution, the organisms metabolize and consume oxygen. The basis for the obligate parasitism of these cells is that they require the rich cytoplasm to stabilize an unusually permeable cell membrane.

The rickettsia have many of the metabolic capabilities of bacteria, but require an exogenous supply of cofactors to express these capabilities. The response to exogenous cofactors implies an unusually permeable cytoplasmic membrane.

Growth and Multiplication

Rickettsia normally multiply by transverse binary fission. Under poor nutritional conditions, the rickettsia cease dividing and grow into long filamentous forms, which subsequently undergo rapid and multiple division into the typical short rod forms when fresh nutrient is added. Immediately after division, the rickettsia engage in extensive movements through the cytoplasm of the cell. *C. burnetii* differs from other rickettsia in that it is enclosed in a persistent vacuole during growth and division. Six to ten daughter cells will form within a host cell before the cell ruptures and releases them.

Pathogenicity

In their arthropod vectors, the rickettsia multiply in the epithelium of the intestinal tract; they are excreted in the feces, but occasionally gain access to the arthropods salivary glands. They are transmitted to man, via the arthropod saliva, through a bite. In their mammalian host, they are found principally in the endothelium of the small blood vessels, particularly in those of the brain, skin and heart. Hyperplasia of endothelial cells and localized thrombus formation lead to obstruction of blood flow, with escape of RBC's into the surrounding tissue. Inflammatory cells also accumulate about affected segments of blood vessels. This angiitis appears to account for some of the more prominent clinical manifestations, such as petechial rash, stupor and terminal shock. Death is ascribed to damage of endothelial cells, resulting in leakage of plasma, decrease in blood volume, and shock.

It is assumed that the observed clinical manifestations of a rickettsial infection are due to production of an endotoxin, although this endotoxin is quite different in physiological effects from that produced by members of the Enterobacteriaceae. This is inferred, although the toxin has not been isolated, from these facts:

1. IV-injected rickettsia cause rapid death in experimental animals.

2. UV-irradiation of rickettsia diminished their infectivity without reducing toxicity.

3. The use of anti-rickettsial drugs does not prevent rapid death in experimental animals.

4. Antiserum specific for cell wall antigens of the rickettsia prevents the toxic effect.